

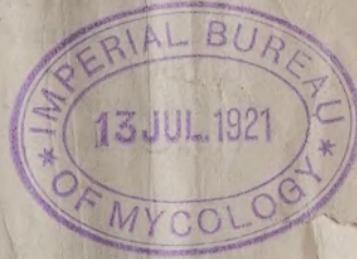
Alma W. Patter

WASHINGTON STATE AGRICULTURAL COLLEGE
and
SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

Bulletin 70



Department of Botany and Zoology

THE POWDERY MILDEWS
OF WASHINGTON.

BY W. H. LAWRENCE

1905

All bulletins of this station sent free to citizens of the state on application to the Director.

ALLEN BROS., PRINTERS, PULLMAN.

THE AGRICULTURAL EXPERIMENT STATION.

BOARD OF CONTROL:

F. J. BARNARD, <i>President</i>	- - - - -	Stle
R. C. McCROSKEY	- - - - -	Gald
H. D. CROW	- - - - -	Spine
J. P. SHARP *	- - - - -	Ellenrg
U. L. ETTINGER, <i>Treasurer</i>	- - - - -	Tax

STATION STAFF.

ENOCH A. BRYAN, A. M., LL.D.,	- - - - -	Dtor
President of the College.		
ELTON FULMER, M. A.,	- - - - -	State Enst
S. B. NELSON, D. V. M.,	- - - - -	Veterian
E. E. ELLIOTT, M. S.,	- - - - -	Agricust
O. L. WALLER, PH. M.,	- - - - -	Irrigation Ener
R. W. THATCHER, M. A.,	- - - - -	Cist
R. K. BEATTIE, A. M.,	- - - - -	Acting Bist
H. S. DAVIS, PH. B.,	- - - - -	Assistant Zcrist
GEORGE SEVERANCE, B. S.,	- - - - -	Assistant Agricrist
A. L. MELANDER, M. S.	- - - - -	Assistant Entomist
MAYNARD ROSENBERGER, D.V.M.	- - - - -	Assistant Veterian
W. H. LAWRENCE, M. S.	- - - - -	Assistant Enst

Deceased, February 9, 1905.

The Powdery Mildews of Washington

BY W. H. LAWRENCE

The little plants commonly called powdery mildews, more rarely as leaf mildews or white mildews are very low forms of plant life that are called fungi. Fungi differ from other forms of plant life in not containing the green coloring matter called chlorophyll that gives green plants their characteristic color. Any plant that contains chlorophyll has the power to manufacture its own food material from the water and air. Since powdery mildews do not contain chlorophyll and cannot manufacture their own food they are forced to take it in an organized condition.

Mode of Life.

Some fungi find it most convenient to take their food from various forms of dead or decaying matter while others take their food from some form of living animal or plant. The former we call saprophytes and the latter parasites. The powdery mildews are parasites. They differ from a majority of other fungi that are parasitic in that the plant body of the parasite does not grow on the inside of the host but that it is wholly external and is only attached to the host by small root-like organs.

Hosts and Host Restriction.

Although these little parasites will not grow on other than the flowering plants. They may be found on the leaves, flowers, fruit, or young twigs. Generally they are found only on the leaves or on both the leaves and twigs but occasionally they attack leaves, twigs and fruit. Some forms also attack flowers.

There is a very marked difference in the susceptibility of certain hosts to the various species of mildew. Hackberry mildew

is a widely distributed but rare species. The mildew on the willow and cottonwood is not found on other than these plants. The one on the grape is confined to the grape in this section. Another form attacks the grasses. Others do not show much preference in selecting their hosts but occur on species of many families. Occasionally two kinds may grow on the same individual plant.

Effect on the Host.

The effect on their respective hosts varies with different species and hosts. The immediate effect is to lessen the vitality. In some cases the infested tissues are more or less shrunken or distorted though very often no change is noticeable. In extreme cases the death of the host occurs. The rolled leaves of the apple, the shrunken berries of the gooseberry, the so-called shelling of grapes, the misshapen and cracked, unripened fruit of the peach, and the blighting of peas are good examples.

The Spread of the Mildew.

The mildews appear at various times during the spring and summer. Very often growth begins early in the season but the fungus develops slowly and is little noticed until it has involved considerable areas of the host. As a general rule they do not do very much damage unless conditions become favorable. Dry, warm weather and an abundance of the particular host is usually accompanied by a rapid spread. Wet, cool weather prevents largely the spread of the disease.

Appearance of Diseased Plants.

Since the fungus occurs more frequently on the leaves than on the stem or fruit they are usually quite readily seen. They are quite easily recognized early in their development by the web-like and dusty-whitish appearance given the infested portion. Occasionally some form a dense nearly white felt-like surface which in some cases becomes dark brown late in development; in other cases it finally disappears and the mildewed surface becomes inconspicuous.

Structure and Life History.

The mycelium.—The web-like and dusty-whitish surface is composed of a greater or less number of threads each called a

hypha (plural hyphae). These hyphae branch freely and intertwine so that many times dense, mat-like patches are formed. All these hyphae are collectively known as the mycelium. The mycelium is external and is attached to the hosts by small disk-shaped and tubular organs called haustoria. The haustoria not only attach the mycelium to the host but absorb food material from it. They only penetrate the host a very short distance.

The summer spores.—Shortly after the young mycelium makes its appearance numerous upright stalks called conidiophores are formed upon it. Each little stalk elongates and becomes many-celled. Later each cell grows into a summer spore or conidium—hence the summer spores are borne in rows or chains. These summer spores mature in a very short time and soon become separated from each other. They are capable of germinating at once after becoming detached. If they come in contact with a suitable substratum, each, upon germinating will attach itself by sending a sucking organ into the substratum and will form a mycelium, which, in its turn, will give rise to upright stalks and chains of summer spores. In this way the summer spores spread the fungus during the growing season of the host upon which it is a parasite. There may be one to many crops of these summer spores, depending on the conditions of the weather.

Winter Spores.—Usually late in summer or autumn small round bodies called perithecia make their appearance on the mycelium. At first they are yellowish in color but as they develop they become dark-brown or almost black. They remain on the mycelium attached to the host for a period of time but usually finally become free and disappear. The perithecia usually bear arm-like growths from their outer walls called appendages. In some forms they are variously branched or forked, a character which adds much to the beauty of the fungus in some forms. They aid in distribution. Inside each perithecium are developed from one to several colorless little sacs called asci (singular ascus). They are attached to its base. Two to eight winter spores, also called ascospores, are produced in each sac. The winter spores remain enclosed in these little sacs until the following growing season of the host, at which time they are set free by the

irregular rupturing of the walls of the perithecium. These winter spores, when they come in contact with a suitable host and germinate, are capable of causing the fungus to again make its appearance, and thus insures the wintering of the fungus during the dormant season of the host.

Vitality of Summer Spores and Winter Spores.

The summer spores serve the purpose of spreading the mildew during the growing season of the host. It is a rare thing to induce summer spores to germinate even as late as early autumn thus showing that they do not retain their vitality for a very long period of time. Winter spores will not germinate until after a period of rest, probably until early spring.

Combatting the Mildews.

Since the plant body (mycelium) of mildews is found on the outside of the plant on which it grows the problem of combatting them is not as difficult as with many other diseases. One or more applications of the proper spray is sufficient to remove the mycelium and thus stop further growth and spread of the fungus. Of the forms in this state several of them cause diseases of cultivated plants. A majority of them live on wild plants.

Species Causing Diseases of Cultivated Plants.

With the possible exception of the Grape mildew growing on the cultivated grape in several sections of the state few have caused much damage. Occasionally in restricted areas, when climatic conditions are most favorable, mildew of the apple and peach become abundant and do considerable damage. Gooseberry mildew often destroys the entire crop of gooseberries. Pea mildew likewise may cause the blight of an entire field of peas. Mildew of the Cherry, Columbine, Grass and Rose are not infrequent.

Notes on Diseases.

1. Pea Mildew (*Erpsiphe polygoni* DC.). Pea mildew usually appears rather late in the season after a majority of the plants are nearly mature and as a result causes but little damage. When it does appear early in the season it usually becomes abundant enough to destroy the crop. The leaves, stem and fruit

become covered with a whitish felt-like surface. From a distance the plants appear as if dusted with flour. This mildew also attacks numerous other cultivated plants. It can be held in check by spraying with Bordeaux mixture or Cupram or by dusting with flowers of sulphur.

2. Cherry Mildew (*Podosphaera oxyacanthae* DC.). The mildew appears on the leaves of the cherry late in the season after the fruit is nearly mature. Appearing at such a time of the year little injury is done. Should it appear early in the season and become abundant it can be combatted by spraying with Bordeaux mixture.

3. Gooseberry Mildew (*Sphaerotheca mors-uvae*). This mildew attacks the cultivated gooseberry. It covers the leaves, young twigs and destroys the fruit by covering it with a thick layer of mycelium of a dark-brown color. It is quite widely distributed throughout the United States and numerous experimenters have tried various sprays. Potassium sulphide has proven the most efficient. Applications should be made early in the season to protect the young leaves. Two to four applications each season will prevent the disease. To make the spray dissolve 1 oz. of potassium sulphide in 2 gallons of water.

4. Apple Mildew. The identity of this mildew has not yet been established. It is probably *Podosphaera oxyacanthae*. It attacks water sprouts, young twigs and leaves. It is most frequently found on nursery stock. It forms a powdery-whitish surface which later becomes a dirty white. When abundant on the leaves it causes them to roll up and occasionally to fall off. The disease can be controlled by the use of either Bordeaux mixture or potassium sulphide.

5. Peach Mildew. The mildew is widely distributed in the peach growing districts. It attacks the leaves, twigs and fruit forming whitish felt-like patches. The patches on the fruit soon become dark-brown, the flesh dry and woody and does not make a normal growth. Frequently the fruit splits open exposing the pit. The identity of this mildew has not been fully established. It is probably the same as the apple mildew or a variety of it.

6. Grape Mildew, Vine Mildew (*Uncinula necator* Schw.).

Grape mildew has been known as a pest of the vineyard for many years. It is found in nearly every grape growing district in the world. As a rule the fungus forms the powdery-whitish surface so characteristic of mildews, on the upper surface of the leaves. It sometimes attacks and destroys the fruit. European varieties of grapes are more susceptible than American varieties. The mildew does not do nearly as much damage in this section of the country as in some others. The amount of damage has not amounted to a great deal. The mildew is combatted by the same methods as other mildews. Bordeaux mixture and potassium sulphide have been used in various grape growing districts with greater or less success. Flowers of sulphur applied with a bellows, the so-called method of dusting, is sometimes used. Two or three applications are made. The first should be made two weeks before blooming time, the second at blooming time and the third three or four weeks later. It is held that flowers of sulphur is slowly volatile at a temperature of 80 deg-100 deg F., and the fumes given off prevent the growth of the summer stage. The efficiency of this substance is somewhat questionable.

Forms Occuring in the State.

In the following pages is given descriptions of the species and varieties known to occur in the state, accompanied by a description of the family and genera, and generic and specific keys.

FAMILY ERYSIPHACEAE Lev.

Parasitic on flowering plants; mycelium white when young, but later becoming brownish in some of the species, persistent or vanishing, wholly external to the tissues of the host plant; conidia large, one-celled, colorless or whitish, oval, oblong or barrel-shaped, borne singly or in basipetal succession on septate, colorless or whitish conidiophores; perithecia round or somewhat flattened, not perforated, sessile on the mycelium, at first yellowish, but becoming brownish or black; perithecium-walls composed of several layers of cells; cells conspicuous or obscure, regular or irregular; appendages present (rarely absent) apical, lateral or equatorial, simple or dichotomously branched at the apex; asci one-several, rising from the base of the perithecia, oval, ovate, oblong, cylindrical or clavate, usually stalked, hyaline; spores two-eight, non-septate, oval, oblong or rarely becoming bent, hyaline or rarely colored yellowish or brownish.

Appendages of the perithecium similar to the mycelium and often interwoven with it, not branched in an definite manner at the apex.

Ascus solitary in each perithecium.	1. SPHAEROTHECA
Asci several in each perithecium.	2. ERYSIPHE

Appendages of the perithecium dissimilar to the mycelium and never interwoven with it, coiled, awl-shaped and expanded at the base, or branched in a definite manner at the apex.

Appendages coiled at the apex.	3. UNCIUNULA
Appendages awl-like, expanded at the base	4. PHYLLACTINIA

Appendages branched in a definite manner at the apex.

Ascus solitary in each perithecium	5. PODOSPHAERA
Asci several in each perithecium	6. MICROSPHAERA

I. SPHAEROTHECA Lev.

Perithecia globose; ascus solitary, eight-spored; appendages, when present, colorless or brown, spreading horizontally, simple or vaguely branched, interwoven with the mycelium.

Mycelium persistent, thick, felt-like dark brown, forming dense patches in which the perithecia are partly imbedded. S. MORS-UVAE

Mycelium rarely persistent, never felt-like; perithecia never imbedded in the mycelium.

Perithecia with cells in the outer wall measuring 10-20 mmm. wide, averaging about 15 mmm.	S. HUMULI
---	-----------

Perithecia with cells in the outer wall measuring 16-40 mmm. wide, averaging about 25 mmm.	S. HUMULI VAR. FULIGINEA
---	--------------------------

S. mors-uvae Schw. Mycelium felt-like, at first white but later becoming dark brown, crooked, sparingly branched, septate when young but becoming thick-walled so that the cells become obliterated; perithecia gregarious, 67-115 mmm. in diameter, globose, rarely irregular in shape, partly imbedded in the dark, felt-like mycelium, with cells 10-20 mmm. wide, becoming obscure with age; appendages present or absent, when present few in number, short and twisted, rarely longer than twice the diameter of the perithecium; ascus oblong or ovate, 67-90 x 52-64 mmm.; spores 20-28 x 11-15 mmm. On cultivated gooseberries.

S. humuli DC. Mycelium usually disappearing with age, rarely forming white patches; perithecia scattered or gregarious, 60-128 mm. in diameter, with cells 10-20 mm. wide, averaging about 15 mm.; appendages variable in number or absent, more or less straight to twisted and interwoven, colorless, pale brown or dark brown, septate, averaging about 5 mm. wide; ascus oblong, elliptical or broadly elliptical, usually short-stalked, 50-90 x 45-73 mm.; spores eight, 20-28 x 12-18 mm. A very common species growing on numerous hosts throughout the State.

S. humuli var. *fuliginea* Schl. (Figs. 3 and 8) Mycelium usually vanishing, rarely forming white patches; perithecia scattered or gregarious, 50-100 mm., in diameter, usually 75-85 mm., becoming dark brown or nearly black in age, with cells 16-45 mm. wide, usually 25-30 mm., irregular in shape, distinct; appendages few or many, one-half to nine times as long as the diameter of the perithecium, septate, about 5 mm. wide, colored in part or throughout, branched, crooked and interwoven; ascus six to eight spored, oblong, 50-52 x 66-70 mm.; spores 20-23 x 13-15 mm. A widely distributed variety.

II. ERYSIPHE DC.

Perithecia globose or globose-depressed; asci several, two to eight-spored; appendages absent or present, when present simple or branched (not dichotomously) interwoven with the mycelium, which they more or less resemble.

Mature asci on the living host not containing spores E. GRAMINIS
Mature asci on the living host containing spores

Asci two-spored.

Asci two-spored.

E. CICHORACEARUM
E. POLYGONI

E. graminis DC. Mycelium persistent, white or rarely brick-colored, forming dense patches; perithecia scattered or gregarious, 130-275 mm. in diameter, globose or globose-depressed or irregular in shape, partly imbedded in the mycelium, with obscure cells; appendages usually absent, when present less than the diameter of the perithecia, brown; asci 9 to 30, cylindrical to oblong, usually long-stalked; spores not found in the perithecia on living hosts. Growing on grasses throughout the greater part of the State. Not very abundant.

E. cichoracearum DC. (Figs. 9, 20, 21) Mycelium vanishing or persist-

ent forming diffused patches, white or brownish; perithecia scattered or gregarious, 75-160 mmm. in diameter, usually 125-145 mmm., globose or globose-depressed, with obscure cells; appendages very variable, sometimes absent, when present few to many, crooked and interwoven with the mycelium, not exceeding in length five times the diameter of the perithecium, usually short, brown or colorless, septate; ascii 5 to 29, cylindrical to broadly ovate, stalked, 50-96 x 28-64 mmm.; spores two, rarely three, very rarely four, 25-35 x 19-26 mmm., ovate, oblong or curved. Common.

E. polygoni DC. Mycelium persistent, thin, cobwebbed, or thick and dense or vanishing; perithecia scattered or gregarious, 80-160 mmm. in diameter, usually 85-90 mmm.; appendages absent or present, when present usually numerous, as long as 10 times the diameter of the perithecium, usually interwoven with the mycelium, simple or branched, septate when colored; ascii 2 to 18, usually 2 to 9, 45-70 x 27-51 mmm., varying much in shape, usually ovate, with or without stalks; spores three to eight, usually three to six, very rarely two, 19-30 x 10-14 mmm. A very common species growing on numerous hosts.

III. UNCINULA LEV.

Perithecia globose-depressed; appendages unlike and free from the mycelium, usually simple, but occasionally once dichotomously forked, coiled at the apex, usually colorless, but sometimes colored for a part of their length.

Appendages septate, colored for more than half their length. *U. NECATOR*
Appendages non-septate, colorless.

Appendages delicate, narrow, 3-4 mmm. wide, stiff, not swollen at the tips *U. PARVULA*

Appendages stouter, wider, weak, somewhat swollen at the tips.

U. SALICIS

U. necator Schw. (Figs. 7 and 15) Mycelium thin and scattered or persistent, forming white felt-like patches, sometimes vanishing; perithecia scattered, 80-145 mmm. in diameter, usually 105-120 mmm., with fairly distinct cells which are irregular in size and shape; appendages five to thirty, 475-660 mmm., long, flattened and weak, septate, colored for more than half their length, with coiled (helicoid) apices; ascii 4 to 11, usually 7 to 8, broadly ovate to ovate-oblong, usually stalked, 58-74 x 35-50 mmm.; spores three to seven, usually four to six, commonly six, hyaline or rarely light brown, 16-30 x 10-16 mmm. Common in nearly all grape-growing districts in the State.

U. parvula Cook and Beck. (Fig. 17.) Mycelium vanishing; perithecia globose-depressed, 96-140 mmm. in diameter, delicate, with distinct cells which average about 8 mmm.; appendages 40-150 mmm. long, hyaline, slender, simple, non-septate, thick-walled, one-fourth to one and one-fourth, usually one-fourth to three-fourths as long as the diameter of the perithecium, with coiled tips, which are sometimes once dichotomously forked and coiled;

asci 5 to 8, broadly ovate, 48-62 x 32-38 mmm., stalked; spores five to eight, usually six, 20-30 mmm. long. On hackberry (*Celtis occidentalis*) in the Snake River valley.

U. salicis DC. (Fig. 16) Mycelium usually dense, forming white patches; perithecia scattered or densely gregarious, 96-160 mmm. in diameter, usually 115-130 mmm, globose-depressed; appendages numerous, hyaline, thin-walled, septate or occasionally one septate at the base, less than two and one-half times as long as the diameter of the perithecium, slightly swollen at the tips, coiled; asci 4 to 14, usually 7 to 10, 32-40 x 48-64 mmim., broadly ovate, sometimes oblong-elliptical, usually stalked; spores four to six, 19-26 x 11-16 mmm. Growing on leaves of cottonwood and willow trees.

IV. PHYLLACTINIA LEV.

Perithecia large, globose-depressed to lenticular; appendages equatorial, stiff, awl-shaped, with swollen bases, free from and unlike the mycelium; apex of the perithecium usually provided with a mass of delicate, much-branched, short hyaline appendages.

P. corylea Persoon. (Figs. 5 and 22) Mycelium vanishing, rarely persistent, forming white patches; perithecia usually scattered, very rarely gregarious, 150-270 mmm. in diameter, globose-depressed to lenticular, with regular and distinct or obscure cells; apex of the perithecium usually provided with a mass of short, much-branched, delicate hyphæ; appendages aseptate, awl-shaped, swollen at base, equatorial, from less than two to three times as long as the diameter of the perithecium; asci 5 to 36, subcylindrical to ovate-oblong, 52-100 x 23-45 mmm.; spores two, rarely three or four, variable in size and shape, oblong or occasionally wider at one end, 32-45 x 16-25 mmm. A very common species growing on numerous hosts. Easily distinguished from other genera by the awl-shaped appendages with swollen bases.

V. PODOSPHÆRA KUNZE.

Perithecium globose or globose-depressed; appendages apical or lateral, colorless or colored, septate, unlike and distinct from the mycelium, dichotomously forked at the apex, with ultimate knob-shaped tips; asci solitary, eight-spored.

Appendages more or less spreading and usually equatorially placed; ultimate branches knob-shaped. *P. oxyacanthæ*

Appendages erect, springing from near the apex; ultimate branches, when present, knob-shaped. *P. oxyacanthæ* VAR. *TRIDACTYLA*

P. oxyacanthæ DC. (Fig. 11.) Mycelium usually vanishing, rarely persistent, forming white patches; perithecia scattered or gregarious, 80-100 mmm. in diameter, globose or globose-depressed, with large and fairly distinct cells; appendages more or less equatorially placed, sometimes one or more arising on the side of the perithecium, 80-200 mmm. long, rarely longer, very

unequal in length on the same perithecium, 3 to 20, septate and colored for the greater part of their length, stiff, thin-walled, with apices two to four times dichotomously branched; primary branches very rarely elongated, usually short and equal, with ultimate tips swollen and knob-shaped, usually compact, never colored; ascus broadly oblong or sub-globose, 60-90 mmm. long; spores usually eight, sometimes six or seven, 16-29 x 10-17 mmm. Growing on leaves of cultivated cherries, apples and snowberry.

P. oxyacanthae var. *tridactyla* Wallr. Mycelium vanishing or persistent, forming white patches; perithecia scattered or gregarious, 70-95 mmm. in diameter, rarely more than 100 mmm., globose or globose-depressed, with cells 10-15 mmm. wide; appendages one to seven, usually three to five, one to seven and one-half times as long as the diameter of the perithecium, usually unequal in length on the same perithecium, arising at the apex more or less erect, short and stiff, or long and somewhat lax, grouped, septate, dark brown for more than half their length or rarely colored throughout, simple or one to three times dichotomously branched, with primary branches sometimes re-curved, occasionally long, and the ultimate tips much swollen and knob-shaped; ascus 54-64 x 54-70 mmm., globose, sub-globose or oblong; spores eight, 18-26 x 13-16 mmm., oblong, sometimes ovate or knee-shaped or narrowed at one end. Growing on leaves of the cultivated cherry and peach.

VI. MICROSPHÆRA Lév.

Perithecia globose or globose-depressed; asci several, two to eight-spored; appendages unlike and free from the mycelium, dichotomously branched at the apices.

Tips of some or all the ultimate branches re-curved.

Spores small, four to eight, 18-23 x 10-12 mmm.

M. ALNI

Spores large.

Spores four to eight, 20-30 x 13-16 mmm.; appendages all regularly dichotomously branched at the apices, with some of the primary branches occasionally elongated or re-curved.

M. ALNI VAR. VACCINII

Spores four to eight, 22-29 x 11-16 mmm.; appendages not regularly dichotomously branched at the apices either bearing sets of opposite branches or pinnately branched. M. ALNI VAR. CALOCLADOPHORA

Tips not re-curved; ultimate branches long and spreading widely.

M. DIFFUSA

M. alni DC. (Fig. 10) Mycelium vanishing; perithecia scattered, 100-130 mmm. in diameter, globose-depressed, with large and distinct cells; appendages four to fifteen, one to two times as long as the diameter of the perithecium, colorless, non-septate, with thick walls, stout, sometimes larger just below the tip than at the base, with apices three to six times dichotomously branched, and the ultimate tips strongly re-curved; ascii 3 to 8, ovate, ovate-oblong, or globose, 48-70 x 32-50 mmm., usually stalked; spores four to eight, usually eight, rarely four or six, 18-23 x 10-12 mmm. Growing

on leaves of alder (*Alnus rubra*). *Phyllactinia corylea* also grows upon the alder. Both forms are sometimes found growing on the same leaf, and occasionally on the same spot.

M. var. vaccinii Schw. (Figs. 13 and 14.) Mycelium persistent, thin and scattered, forming indefinite whitish patches or vanishing; perithecia scattered, rarely gregarious, 95-165 mmm. in diameter, with distinct cells very variable in size and shape; appendages eight to twenty-six, two to five times as long as the diameter of the perithecium, occasionally bent, rarely becoming somewhat flaccid, colorless or colored only at the base, aseptate or one to three septate, becoming thick-walled below, thin-walled above, two to five times dichotomously branched, with close and compact or long and loose and occasionally re-curved branches, the ultimate tips of which are quite regularly and distinctly re-curved; ascii as many as eleven, 60-80 x 35-43 mmm., ovate to ovate-oblong, with or without short stalks; spores four to six, 20-30 x 13-16 mmm. Growing upon wild vetch in eastern Washington. Very rare.

M. alni var. calocladophora Atkinson. (Figs. 12 and 19.) Appendages rarely dichotomously branched at the apex, usually bearing sets of opposite branches or digitately forked; ascii three to eight, 60-70 x 40-50 mmm.; spores four to six, 22-29 x 11-16 mmm. This form grows on the oak (*Quercus garryana*) in the Puget Sound region.

M. diffusa Cook and Peck. (Figs. 4 and 18.) Mycelium persistent, forming indefinite patches or thin and effused and often vanishing; perithecia scattered or gregarious, 50-100 mmm. in diameter, usually 80-100 mmm., globose-depressed, with distinct cells; appendages six to twenty, two to seven and one-half times as long as the diameter of the perithecium, smooth, aseptate, or one to three septate, colorless or colored near the base, weak when long, thin-walled above, becoming thick-walled below, three to five times dichotomously branched, diffuse and irregular, the ultimate tips not being re-curved; ascii four to eight, 48-62 x 28-32 mmm., ovate-oblong, short-stalked; spores three to six, usually four, 18-22 x 8-11 mmm. Growing on the leaves of the snowberry.

INDEX TO PLATE.

Figure

1. Young conidiophore of *Sphaerotheca humuli* bearing two conidia or summer spores; mag. 365 times.
2. A conidiophore of *Erysiphe cichoracearum* bearing several conidia in a chain or row; mag. 365 times.
3. A mature perithecium of *Sphaerotheca humuli* var. *fuliginea*, magnified 130 times. The cells in the wall of the perithecium are more regular than in most instances in this species; the appendages are long and thread-like, and are usually colored for the greater part of their length.
4. A mature perithecium of *Microsphaera diffusa*, magnified 170 times. The cells in the walls are large and irregular; the appendages are thick-walled at the base; the apex of an appendage is shown in Figure 18.
5. A mature perithecium of *Phyllactinia corylea* magnified 150 times. The cells in the wall of the perithecium are small and quite regular in size; the appendages are awl-shaped and swollen (bulbous) at the base; an ascus is shown in Fig. 6.
6. An ascus of *Phyllactinia corylea* containing two spores; magnified 200 times.
7. An ascus of *Uncinula necator* containing six spores; magnified 260 times.
8. An ascus of *Sphaerotheca humuli* var. *fuliginea* containing 3 spores; magnified 200 times.
9. An ascus of *Erysiphe cichoracearum* containing 3 spores; magnified 260 times.
10. The apex of an appendage of *Microsphaera alni*, enlarged.
11. The apex of an appendage of *Podosphaera oxyacanthae*, enlarged.
- 12 and 19. Two forms of the apexes of the appendages of *Microsphaera alni* var. *calocladophora*, enlarged.
- 13 and 14. Two forms of the apexes of the appendages of *Microsphaera alni* var. *vaccinii*, enlarged.
15. The apex of an appendage of *Uncinula necator*, enlarged.
16. The apex of an appendage of *Uncinula salicis*, enlarged.
17. The apex of an appendage of *Uncinula parvula*, enlarged.
18. The apex of an appendage of *Microsphaera diffusa*, enlarged.
19. See 12 and 19.
- 20 and 21. Parts of the appendages of *Erysiphe cichoracearum*, enlarged.
22. A single cell from the apex of the perithecium of *Phyllactinia corylea*, showing the branching of the secondary appendages near their base; magnified about 600 times.

